In the United States Patent and Trademark Office

Appn. Number: _____

Appn. Filed: _____

Applicant(s): Johs

Appn. Title: General Virtual Interface Algorithm - - -

Examiner/GAU: _____ /324

Mailed: With Application

At: _____

Information Disclosure Statement

Commissioner of Patents and Trademarks
Washington, District of Columbia 20231

Sir:

Attached is a completed Form PTO-1449 and copies of the pertinent parts of the references cited thereon. Following are comments on these references pursuant to Rule 98:

PATENTS

Patent No. 4,770,895 to Hartley is disclosed as it describes a application of ellipsometry controling growth of alloy films.

Patent No. 5,091.320 to Aspnes is disclosed as it describes application of ellipsometry to controlling material growth.

Patent No. 5,626,117 to Wielsch et al. is disclosed as it it describes a method for determining characteristic values of transparent layers using ellipsometry.

Patent No. 5,582,646 to Woollam et al., is disclsoed as it describes a system for applying ellipsometry to investigate samples.

Patent No. 5,929,995 to Johs is disclsoed as it describes a system for use in directing beams in process chambers.

Patent No. 6,573,999 to Yang is disclosed as it describes determining film thickness using light absorbtion of material underlying a film.

Patent No. 4,934,788 to Southwell is disclosed as it describes depositon of coatings using rate control.

ARTICLES

The following articles are disclosed, some as general background, and many for indicated specific reasons:

1. "Optical Characterization of Continuous Compositional Gradients in Thin Films by Real Time Spectroscopic Ellipsometry", S. Kim and R.W. Collins, Appl. Phys. Lett. 67 (1995), 3010.

2. "Growth of $Al_xGa_{1-x}As$ Parabolic Quantum Wells by Real-Time Feedback Control of Composition", D.E. Aspnes, W.E. Quinn, M.C. Tamargo, M.A.A. Pudensi, S.A. Schwarz, M.J.S.P. Brasil, R.E. Nahory, and S. Gregory, Appl. Phys. Lett. 60 (1992), 2776.

3. "Real-time Control of the MBE Growth of InGaAs in InP", J.A. Roth, D.H. Chow, G.L. Olson, P.D. Brewer, W.S. Williamson, and B. Johs, J. Crystal Growth 201/202 (1999), 31.

4. "Status of HgCdTe-MBE Technology for Producing Dual-Band Infrared Detectors", R.D. Rajavel, P.D. Brewer, D.M. Jamba, J.E. Jensen, C. LeBeau, G.L. Olson, J.A. Roth, W.S. Williamson, J.W. Bangs, P. Goetz, J.L. Johnson, E.A. Patten, J.A. Wilson, J. Crystal Growth 214/215 (2000), 1100.

5. In Situ Multi-Wavelength Ellipsometric Control of Thickness and Composition for Bragg Reflection Structures", C. Herzinger, B. Johs, P. Chow, D. Reich, G. Carpenter, D. Croswell, and J. Van Hove, Mat. Res. Soc. Symp. Proc. Vol. 406 (1996), 347.

6. "Closed-loop Control of Resonating Tunneling Diode Barier Thickness Using In Situ Spectroscopic Ellipsometry", J.A. Roth, W.S. Williamson, D.H. Chow, G.L. Olson, and B. Johs, J. Vac. Sci. Technol. B 18 (2000), 1439.

7. "In situ Spectral Ellipsometry for Real-Time Measurement and Control", W.M. Duncan and S.A. Henck, Appl. Surf. Sci. 63 (1993), 9.

8. "In Situ Ellipsometric Diagnosis of Multilayer Thin Film Deposition During Sputtering", X. Gao, D.W. Glenn, and J.A. Woollam, Thin Solid Films 313-314 (1998), 511.G.E. Jellison Jr., Thin Solid Films 234 (1993), 416.

Traditionally, a layered optical model is used to analyze SE data, see references [9,10]).

9. "Spectroscopic Ellipsometry Data Analysis: Measurement

Versus Calculated Quantities", G.E. Jellison Jr., Thin Solid Films 313-314 (1998), 511.

10. "Overview of Variable Angle Spectroscopic Ellipsometry (VASE), Part 1: Basic Theory and Typical Applications", J.A. Woollam, B. Johs, C.M. Herzinger, J. Hilfiker, R. Synowicki, and C. L. Bungay, SPIE Critical Reviews Vol. CR72 (1999), 3.

In situ ellipsometry "near surface" data analysis algorithms have been developed, see references [11-19]).

Virtual interface (VI) algorithms based on the common pseudo-substrate approximation (CPA), see references [11-12]),

11. "Minimal-data Approaches for Determining Outer-layer Dielectric Responses of Films From Kinetic Reflectometric and Ellipsometric Measurements", D.E. Aspnes, J. Opt. Soc. Amer. A 10 (1993), 974.

12. "Optical Approaches to Determine Near-Surface Compositions During Epitaxy", D.E. Aspnes, J. Vac. Sci. Technol. A 14 (1996), 960. F.K. Urban III and M.F. Tabet, J. Vac. Sci. Technol. A 11 (1993), 976.

The derivation of the disclosed invention equations is similar to that of Urban, see reference [13]), in that exact thin film equations are used in the calculation.

13. "Virtual Interface Method for In Situ Ellipsometry fo Films Grown on Unknown Substrates", F.K. Urban III and M.F. Tabet, J. Vac. Sci. Technol. A 11 (1993), 976.

Simplifying assumption used by the CPA to calculate the VI parameters is not universally valid, see references [14,16,19]),

14. "Real Time Monitoring of the Growth of Transparent Thin Films by Spectroscopic Ellipsometry", M. Kildemo and B. Drevillon, Rev. Sci. Instrum. Vol. 67, No. 5 (1996), 1957.

15. "Characterization of Quasi-Rugate Filters Using Ellipsometric Measurements", A.V. Tikhonravov, M.K. Trubetskov, J. Hrdina, and J. Sobota, Thin Solid Films 277 (1996), 83.

16. "Approximation of Reflection Coefficients for Rapid Real-time Calculation of Inhomogeneous Films", M. Kildemo, O. Hunderi, B. Drevillon, J. Opt. Soc. Am. A 14 (1997), 931.

17. "Real-time In Situ Ellipsometric Control of

Antireflection Coatings for Semiconductor Laser Amplifiers Using SiO_x", I-Fan Wu, J.B. Dottellis, M. Dagenais, J. Vac. Sci. Technol. A 11 (1993), 2398.

18. "Real Time Control of Plasma Deposited Optical Filters by Multiwavelength Ellipsometry", T. Heitz, A. Hofrichter, P. Bulkin, and B. Drevillon, J. Vac. Sci. Technol. A 18 (2000), 1303.

19. "Direct Numerical Inversion Method for kinetic Ellipsometry Data. 1. Presentation of the Method and Numerical Evaluation", D. Kouznetsov, A. Hofirchter, and B Drevillon, Appl. Opt. 41 (2002) 4510.

The derivation of the GenVI algorithm presented here is based on the thin film calculation method first proposed by Abeles, (see reference [20]), and uses the optical admittance notation given in Macleod, see reference [21]).

20. "Recherches Sur La Propagation Des Ondes Electromagnetiques Sinusoidales Dans Les Milieuc Stratifies Application Aux Couches Minces", F. Abeles, Ann. De Physique, 5 (1950) 596.

The thin film calculation method is summarized in disclosed invention eqns. 1 - 6 (for more details, consult, see reference [21])).

References 21-23 are books and are not included herewith:

21. "Thin-Film Optical Filters", H.A. Macleod, McGraw-Hill, New York NY, 1989, p. 40.

22. "Ellipsometry and Polarized Light", R.M.A. Azzam and N.M. Bashara, North-Holland, Amsterdam, 1977.

23. "Numerical Recipes in C", W.H.Press, B.P. Flannery, S.A. Teukolsky, and W.T. Vetterling, Cambridge University Press, Cambridge, 1988.

A high speed rotating compensator ellipsometer (RCE) with a CCD-based spectrograph detection system, see reference [24]),

24. Model M2000X, J.A. Woollam Co., Inc., Lincoln, NE USA.

25. "Data Analysis for Spectroscopic Ellipsometry", G.E. Jellison Jr., Thin Solid Films, 234, 1993, 416-422.

26. "In situ and Ex Situ Applications of Spectroscopic Ellipsometry", J. A. Woollam, B. Johs, W. McGahan, P. Snyder,

J. Hale, H. Yao, Mat. Res. Soc. Proc., Vol 324, 1994, p. 15.

SINCERELY,

JAMES D. WELCH
REG. NO. 31,216

Sheet 1 of 3

Form PTO-1449 (Rev. 1-98) — U.S. DEPARTMENT OF COMMERCE, PATENT AND TRADEMARK OFFICE

ATTY. DOCKET NO.	SERIAL NO.
APPLICANT: Johr	
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U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
	AA	4 770 895	9/1988	Hartley	427	10	
	AB	5 091 320	2/1992	Aspner et al	437	F	
	AC	5 552 617	6/1996	Welsch et al	356	369	
	AD	5 582 646	12/1996	Woollam et al	118	708	
	AE	5 929 995	7/1999	Johr	356	369	
	AF	6 573 999	6/2003	Yang	356	632	
	AG	4 933 728	6/1990	Southwell	350	164	
	AH						
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FOREIGN PATENT DOCUMENTS

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EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

PLEASE USE THIS FOR PTO FORM 1449 REGARDING ARTICLES

1. "Optical Characterization of Continuous Compositional Gradients in Thin Films by Real Time Spectroscopic Ellipsometry", S. Kim and R.W. Collins, Appl. Phys. Lett. 67 (1995), 3010.

2. "Growth of $Al_xGa_{1-x}As$ Parabolic Quantum Wells by Real-Time Feedback Control of Composition", D.E. Aspnes, W.E. Quinn, M.C. Tamargo, M.A.A. Pudensi, S.A. Schwarz, M.J.S.P. Brasil, R.E. Nahory, and S. Gregory, Appl. Phys. Lett. 60 (1992), 2776.

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data, see references [9,10]).

9. "Spectroscopic Ellipsometry Data Analysis: Measurement Versus Calculated Quantities", G.E. Jellison Jr., Thin Solid Films 313-314 (1998), 511.

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